Middle East Journal of Agriculture Research
ISSN 2077-4605
Volume : 05 | Issue : 04 | Oct.-Dec. | 2016
Pages: 522-533

Yield and Yield Components of Maize As Affected By Integrated Management of Sheep Manure and Urea Fertilizer

[1]Sajid Khan, [1]Mohammad Tariq Jan, [2]Bilal Ahmad, [1]Tariq Shah and [1]Wisal Ahmad

[1]Department of Agronomy, University of Agriculture, Peshawar,Pakistan
[2]Department of Soil & Environmental Sciences, University of Agriculture, Peshawar,Pakistan

Received: 23 Oct. 2016 / Accepted: 14 Nov. 2016 / Publication date: 15 November 2016

ABSTRACT

To measure the impact of sheep manure (SM) levels, and application timing of SM with or without fertilizer nitrogen (urea) on maize productivity, an experiment was designed during kharif 2015 at Agronomy research farm, University of Agriculture Peshawar. The experiment was carried out in RCB design with split plot arrangement, having four replications. Sheep manure and its application times were applied to main plot, and N fertilizer (urea) were applied to subplot. SM were used at the rate of 3, 4 and 5 t ha^{-1}, incorporated 15 days before sowing and at the time of sowing, and N fertilizers at the rate of 0, 90 and 120 kg ha^{-1}. Plots receiving 5 t ha^{-1} SMproduced maximum plant height (182.50 cm), ears m^{-2} (5.7), No. of grains ear^{-1} (318.7), 1000 grains weight (241.1 g), and grain yield (3402 kg ha^{-1}). Plots treated with SM 15 days before planting produced maximum thousand grains weight (238.4 g) and grain yield (3099 kg ha^{-1}). Application of 120 kg N ha^{-1} resulted in taller plants (184.58 cm), higher ears m^{-2} (5.8), number of grains ear^{-1} (324.9), 1000 grains weight (244.2 g), and grain yield (3448 kg ha^{-1}.The AT x SM interaction significantly influenced grain yield. More increase in grain yield was observed from manure application 15 days before sowing, in comparison to its application at sowing time. Likewise M x N interaction had significantly affected plant height, number of ears m^{-2}, number of grains ear^{-1}, 1000 grains weight, and grain yield. The yield components was increased with increasing N rates across all the SM levels being more obviously at 5 t SM ha^{-1} over either 3 or 4 t SM ha^{-1}. The combined application of sheep manure and nitrogen was found more effective than sole application of either urea or sheep manure.

Key words: Sheep manure, Urea, Yield, Maize.

Introduction

Maize botanically called *Zea mays* L. is the most important high yielding crop in the world. Its height is 1-3 m, developed into a single stem with alternatively arranged ten to fourteen leaves. Maize originated from Central America and then widely introduced in to the rest of the world after the discovery of America (Ezeibekwe *et al*., 2009). It is used in many indigenous and commercial food products such as cooking oil, livestock feed and raw material for the industries like producing baby foods, cookies, biscuits and ice cream (Khatoon *et al.,* 2010).

Sheep manure contain high amount of primary macro nutrients and other essential nutrients for plants (Dekisissa *et al.,* 2008). It increases the soil cation exchange capacity (CEC) and adsorbs more cations such as calcium, magnesium and potassium than sodium (Jalali and Ranjber, 2009). The use of organic matter positively influences vegetative and reproductive growth of plants (Shadanpour, 2011).The chemical fertilizers are so expensive that poor farmers cannot purchase it. Naturally available animal manure and plant residues can be used as an alternative cheaper source of synthetic fertilizers (Khan *et al*., 2005).

Application timing of manure is one of the most important factors that can affect nutrient utilization efficiency of the crop (Randall *et al*., 2003). It is a vital component for increasing nitrogen use efficiency and reducing nutrient losses (Thomsen, 2005). Early application of organic manure is important for nutrient synchronization with crop plants (Edmeades, 2003). To get optimum return from manure it should be applied to match with crop nutrients demand, too early application caused nutrient losses (Ozores, 2012).

Nitrogen is one of the macro nutrient needed by plant in large amounts. In cereals optimum nitrogenous fertilizer results in high crop productivity, high protein content, plumpness of the grain and vigorous vegetative growth. Because of its high mobility nitrogen lost from soil through leaching, and

Corresponding Author: Sajid Khan, Department of Agronomy, University of Agriculture, Peshawar, Pakistan
E-mail: sajidkhan375@hotmail.com

runoff (Arif *et al*., 2010). Nitrogen is indispensable for maize plant, but at the same time it is costly and its overdoses are harmful to plants and contaminate ground water (Hopkins *et al*., 2008). To fulfill the requirement of the crop and to avoid losses through leaching and volatilization proper management is necessary (Le Gouis *et al*., 2007).

The extensive use of chemical fertilizer had degraded soil fertility and lowered soil organic matter. An appropriate combination of natural and synthetic fertilizer is indispensable for retaining long term soil fertility (Shah *et al*., 2009). This experiment was designed to study the response of three sheep manure rates applied before or at sowing with different levels of urea fertilizers for maize productivity in the agro climatic condition of Peshawar.

Materials and Methods

An experiment on "yield and yield components of maize as affected by integrated management of sheep manure and urea fertilizer" was carried out at Agronomy Research Farm, The University of Agriculture Peshawar, during kharif 2015. The experiment consisted of three factors viz. sheep manure (M) (3, 4 and 5 t ha^{-1}), application timing of sheep manure (AT) (15 days before sowing and at the time of sowing) and urea (0, 90 and 120 kg N ha^{-1}). The experiment was designed in RCB split plot arrangements, comprised of four replications. Sheep manure and its application time was allotted to main plot, whereas urea N was allotted to the sub plot of size 5m x 3.5m, having 5 rows 70 cm apart. First treatment of sheep manure was applied 15 days before sowing, and the second at sowing time along with half of nitrogen doses in their respective plots. On 19th June 2015, the crop was sown with the help of seed drill. At knee height stand of the crop second dose of nitrogen was applied to their respective plots. The crop was irrigated when it was necessary. The following characters were studied during the trial period.

Plant height was calculated in each sub plot as the distance between base of the plant near soil to the base of the tassel (excluding tassel) of five representative plants and was averaged. Number of ears m^{-2} was calculated by counting the total ears of three central rows in each subplot and then converted to ears m^{-2} by using the following formula.

$$\text{Number of ears m}^{-2} = \frac{\text{Total number of ears counted}}{\text{R} - \text{R distance} \times \text{row length} \times \text{no. of rows}}$$

Number of grains ear^{-1} were computed by counting number of grains in 10 randomly selected ears from each sub plot and then were averaged.1000 grains were taken randomly from seed lot of each treatment and then weighted with the aid of sensitive electronic balance. From each treatment three central rows were harvested, the harvested plants were then sundried, and threshed. The grains from each sub plot was weighed and then converted into grain yield (kg ha^{-1}) using the formula.

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain weight of three central rows}}{\text{R}-\text{R distance} \times \text{Row length} \times \text{no. of rows}} \text{x } 10{,}000 \text{ m}^2$$

The data was statistically analyzed with appropriate ANNOVA using LSD at 0.05 level of probability (Jan *et al*., 2009).

Results

Plant height

Sheep manure and nitrogen rates had significant effects on plant height, whereas sheep manure application timing was found non significant (Table 1). Except SM x N and SM x AT x N all other interactions were found non significant.

Sheep manure incorporation of 5 t ha^{-1} produced maximum plant height (182.50 cm) followed by the use of 4 t ha^{-1} sheep manure (179.63 cm), whereas the dwarf plants (176.88 cm) were recorded in plots having 3 t ha^{-1} sheep manure. Optimum plant height with increasing sheep manure levels might be due to nutrient retention in soil, improved soil properties and fertility due to microbial activity, and better environment for root growth and development (Fageria, 2012). Our results are in accordance with Iqbal *et al*. (2014) who founded that optimum plant height in compost treated plots was due to abundant and continuous nutrient provision to the root zone of the plant. Maximum plant height were observed in 120 kg N ha^{-1} (184.58 cm), followed by plots having 90 kg N ha^{-1} (179.50 cm), whereas the minimum plant height (174.92 cm) were measured in control plots. Maximum plant height due to higher N levels could be attributed to the fact that N is a component of chlorophyll and enzymes necessary for photosynthesis, its higher levels might have increased the vegetative growth and stem elongation (Cechin and Fumis, 2004).Taller plants obtained from higher nitrogen treatment were an indication of the fact that plant height is highly dependent on nitrogen availability. These finding are in accordance with Achieng *et al*. (2010) who observed taller plants from inorganic fertilizer, manure and combined use of manure and inorganic fertilizer.

Table 1: Plant height (cm) of maize as influenced by combined application sheep manure and urea fertilizer.

Sheep manure (SM, t ha^{-1})	Application time of SM (AT, days)†	Nitrogen rates (N, kg ha^{-1})			SM x AT
		0	90	120	
3	15	171.50	179.50	182.25	177.75
4		171.50	182.50	187.00	180.33
5		181.75	174.75	189.25	181.92
3		172.50	177.75	177.75	176.00
4	0	174.00	179.50	183.25	178.92
5		178.25	183.00	188.00	183.08
	15	174.92	178.92	186.17	180.00
	0	174.92	180.08	183.00	179.33
3		172.00	178.63	180.00	176.88 b
4		172.75	181.00	185.13	179.63ab
5		180.00	178.88	188.63	182.50 a
Mean		174.92 c	179.50b	184.58a	

†*SM application was made 15 or 0 days before sowing*

	Interactions		P-values
$LSD_{0.05}$ for SM =3.54	SM x AT	=	0.639
$LSD_{0.05}$ for AT = NS	SM x N	=	0.014
$LSD_{0.05}$ for N = 2.14	AT x N	=	0.121
	SM x AT x N	=	0.024

Means bearing similar letter(s) are statistically comparable within the same category using LSD test at P≤0.05.

The SM x N interaction (Fig 1) indicated that increasing N had increased the plant height in plots, where 3 or 4 tons sheep manure were incorporated. However, the relative increase in plant height was higher in case of 4 tons SM ha^{-1} over 3 tons SM ha^{-1}.

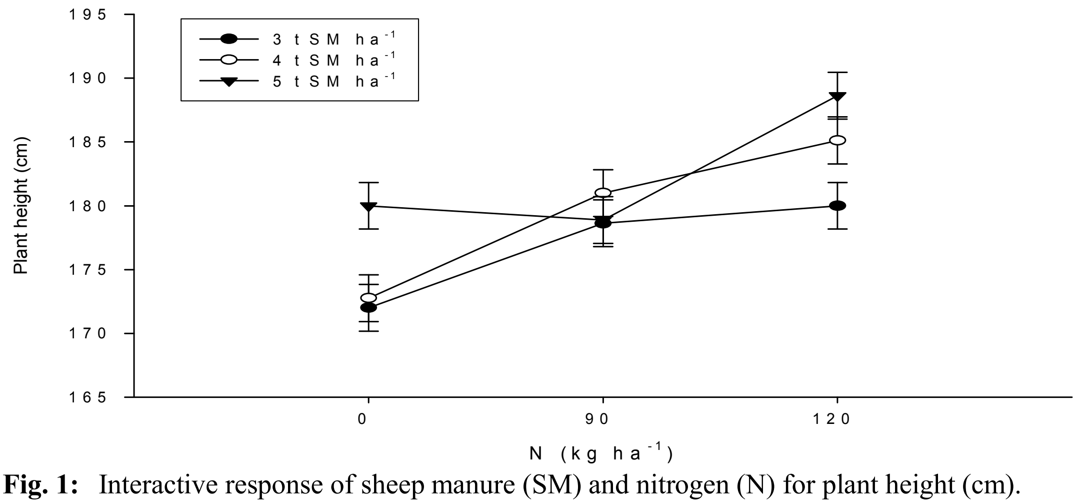

Fig. 1: Interactive response of sheep manure (SM) and nitrogen (N) for plant height (cm).

Moreover, in plots having higher sheep manure (5 tons ha^{-1}) had produced taller plants in plots having only 120 kg N ha^{-1}, and no differences in plant height were observed in plots having no N or 90 kg N ha^{-1}. Regarding the third order interaction (SM x AT x N), plant height was increased with increase in N rates across all the three levels of sheep manure when applied either 15 days before sowing or at the time of sowing (Fig 2). However, the increment in plant height was greater, when the sheep manure were soil incorporated 15 days prior to sowing in comparison to its incorporation at sowing time. The maximum plant height with combined use of sheep manure and N fertilizer could be due to balanced nutrient provision from sheep manure, improved soil properties abundant N availability to crop, which might result in rapid cell division and elongation (Boomsma *et al*., 2009), promoted plant growth, internodes length and number which might have increased plant height (Chen *et al*., 2013). Our results are comparable with the experiment of Sarwar *et al*. (2008) who reported tallest plants from integrated application of compost and N fertilizer.

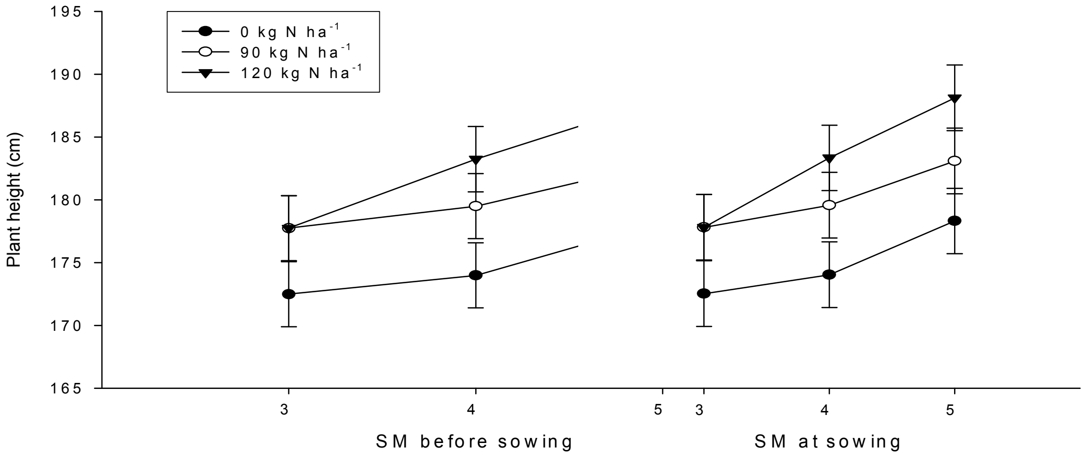

Fig. 2: Sheep manure (SM), application time (AT), and nitrogen (N) interactive response for plant height (cm).

Number of ears m^{-2}

Data perusal (Table 2) showed a profound effect of different rates of sheep manure, and nitrogen, on ears m^{-2} while application time of sheep manure was found non significant. Apart from SM x N all other interactions were found non significant for no. of ears m^{-2}.

Table 2. Ears m^{-2} of maize as influenced by sheep manure and urea fertilizer.

Sheep manure (SM, t ha^{-1})	Application time of SM (AT, days)†	Nitrogen rates (N, kg ha^{-1})			SM x AT
		0	90	120	
3	15	4.2	5.0	5.5	4.9
4		4.4	5.2	5.6	5.1
5		6.1	5.0	6.5	5.8
3		3.7	5.9	5.7	5.1
4	0	4.7	5.3	5.3	5.1
5		5.1	5.4	6.3	5.6
	15	4.9	5.1	5.8	5.3
	0	4.5	5.5	5.8	5.3
3		4.0	5.5	5.6	5.0 b
4		4.6	5.3	5.5	5.1 b
5		5.6	5.2	6.4	5.7 a
Mean		4.7 c	5.3 b	5.8 a	

†*SM application was made 15 or 0 days before sowing*

Interactions		P-values	Interactions		P-values
SM x AT	=	0.602	AT x N	=	0.103
SM x N	=	0.006	SM x AT x N	=	0.392
$LSD_{0.05}$ for SM and AT	=	0.5, NS	$LSD_{0.05}$ for N	=	0.4

Means followed similar alphabets in the same column are identical using LSD test at $P \leq 0.05$.

Maximum ears m^{-2}(5.72) were counted in plots receiving SM treatment of 5 t ha^{-1}, while minimum number of ears m^{-2} (5.00) were recorded from 3 t ha^{-1} SM application which was statistically comparable with 4 t ha^{-1} SM application(5.08 ears).This increase due to higher sheep manure levels could be due to favorable soil condition and decomposition due to soil microbes (Dolan, 2006), timely and steady nutrient availability that might enhanced dry matter production, plant growth and plant physiological functions (Ali *et al*., 2012). These finding are supported by the finding of Achieng *et al*. (2010) and Baloch *et al*. (2015). Optimum ears m^{-2}(5.81) was reckoned from plots where 120 kg N ha^{-1} was used. While smallest number of ears per m^{-2} (4.69) was recorded from control plots. This increased ears m^{-2} with higher N levels could be attributed to better vegetative growth, plant development, and root growth (Adami *et al*., 2012) obtained from increasing N levels. These results are strongly supported by Karasu (2012) who observed greater number of ears plant^{-1} with increasing nitrogen levels. The interaction SM x N (Fig 3) indicated significant increase in number of ears m^{-2} in3 and 4 t SM ha^{-1} with increasing N from 0 to 90 kg ha^{-1}but further increase in N from 90 to 120 kg ha^{-1}having no significant differences for ears m^{-2}. In case of 5 t SM ha^{-1}, the number of ears m^{-2} decreased with increasing N from 0 to 90 kg ha^{-1}, whereas with further increase in N from 90 to 120 kg ha^{-1}, the ears m^{-2} increased. Combined sheep manure and N application produced maximum number of ears m^{-2}in comparison to sole treatment of both sources. This increased response could be attributed to better nourishment of crop due to better plant nutrition, and desirable soil condition associated with manure application (Khaliq *et al*., 2004), that might had increased assimilates production (Baiyeri and Tenkouano, 2008), and increased number of cobs plant^{-1}.Similar results were also documented by Verma *et al*. (2014) and Baloch *et al*.(2015) who obtained higher number of ears m^{-2} with incremental doses of manure, which was further boosted by combined use of natural and chemical fertilizer.

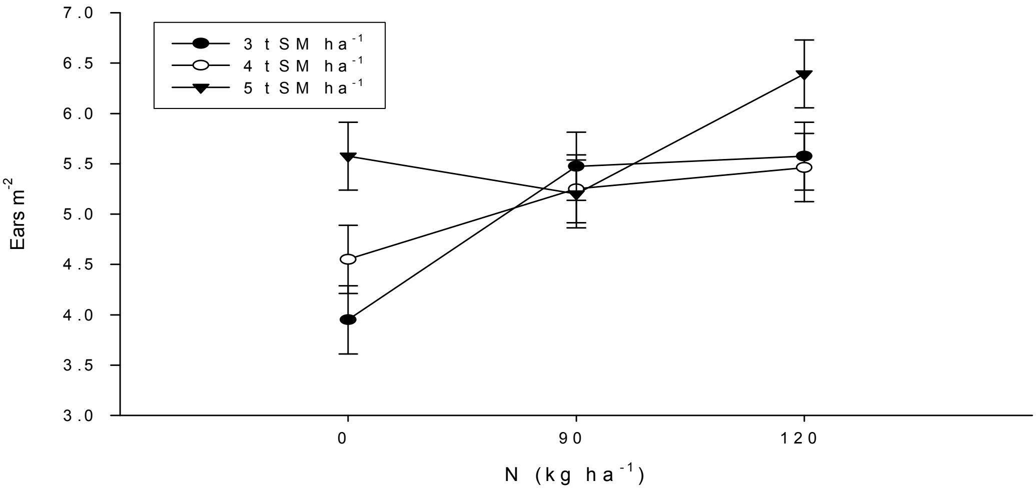

Fig. 3: Interactive response of sheep manure (SM) and nitrogen (N) for number of ears m^{-2}.

Number of grains ear^{-1}

Data analysis showed that number of grains ear^{-1} were considerably influenced by sheep manure and nitrogen rates, while application times of sheep manure were found non significant (Table 3). Among several interaction M x AT, M x N, and M x AT x N was found significant for number of grains ear^{-1}.

Table 3: Grains ear^{-1} of maize in response to combined application of sheep manure and urea fertilizer.

Sheep manure (SM, t ha^{-1})	Application time of SM (AT, days)†	Nitrogen rates (N, kg ha^{-1}) 0	90	120	SM x AT
3	15	248.3	323.3	330.0	300.5
4		266.5	291.8	311.8	290.0
5		328.3	321.3	345.8	331.8
3		265.8	291.5	283.8	280.3
4	0	308.8	283.0	341.5	311.1
5		281.5	298.5	336.8	305.6
	15	281.0	312.1	329.2	307.4
	0	285.3	291.0	320.7	299.0
3		257.0	307.4	306.9	290.4 b
4		287.6	287.4	326.6	300.5ab
5		304.9	309.9	341.3	318.7 a
Mean		283.2 c	301.5 b	324.9 a	

†*SM application was made 15 or 0 days before sowing*

Interactions		P-values	Interactions		P-values
SM x AT	=	0.060	AT x N	=	0.211
SM x N	=	0.038	SM x AT x N	=	0.037
$LSD_{0.05}$ for SM and AT	=	21.0, NS	$LSD_{0.05}$ for N	=	14.2

Means having identical alphabet(s) in the same category are statistically alike using LSD test at P≤0.05.

Maximum grains ear^{-1} (318.7) were figured out from 5 t ha^{-1}sheep manure treatment, followed by the application of 4 t SM ha^{-1}(300.5 grains) while lowest number of grains (290.4) was reckoned in ears produced in plots having 3 t SM ha^{-1}. Increasing sheep manure from lower to higher (3 to 4 t ha^{-1}) had enhanced number of grains ear^{-1}by 29.This enhanced grains number could be associated with enhanced soil physiochemical properties, improved root system, and organic matter decomposition (Ali *et al*., 2011), that might have increased N availability and resulted in higher dry matter production by leaves and their efficient translocation to ears. These results are in agreement with Farhad *et al*. (2009), Shah and Arif (2000) and Khaliq *et al*., (2004). Likewise higher doses of nitrogen (120 kg ha^{-1}) developed greater grain ear^{-1} (324.9) compared to least grains ear^{-1} (283.2 grains) recorded in control plot. This increase might be due to higher rows and grains per row (Hokmalipour and Darbandi, 2011), probably due to higher dry matter production of leaves. These findings are supported by Khan *et al*., (2005) and Onasanya *et al*. (2009). The interaction AT x SM (Fig 4) showed that grains ear^{-1} were decreased with increasing sheep manure from 3 to 4 t ha^{-1} applied before sowing, while further increase in its rate up to 5 t ha^{-1} enhanced grains ear^{-1}. However at sowing time, the incorporation of sheep manure (from 3 to4 t ha^{-1}) increased the grains ear^{-1}, however with further increasing up to 5 t SM ha^{-1}, a slight decrease in grains ear^{-1} was observed. The SM x N interaction (Fig 5) depicted that higher levels of sheep manure (4 and 5 t ha^{-1}) with increasing N levels (0 and 90 kg ha^{-1}) did not increased significantly the number of grains ear^{-1}, while with higher N levels (120 kg ha^{-1}) a little increase was observed. In 3 t SM ha^{-1} a significant increase was recorded with N (from 0 and 90 kg ha^{-1}), but having no increase thereafter. Regarding SM x AT x N interaction (Fig 6), Increasing SM incorporation from 3 to 5 t ha^{-1}, the grains ear^{-1}showed a linear increasing trend (control plots and 15 days before SM application), slight decreasing trend (90 kg N ha^{-1} and SM applied at sowing time) whereas the quadratic response were observed for other combination. The observed trends with increasing SM for 120 kg were opposite when SM applied before sowing and at the time of sowing. N in combined application with sheep manure produced highest number of grains ear^{-1}which was further aggravated by combining with SM application before planting. This increase could be due to slow release and constant provision of nutrients by manure through mineralization and favorable soil environment produced by manure (Baloch *et al*., 2015). These results are in line with the report of Verma *et al*. (2014).

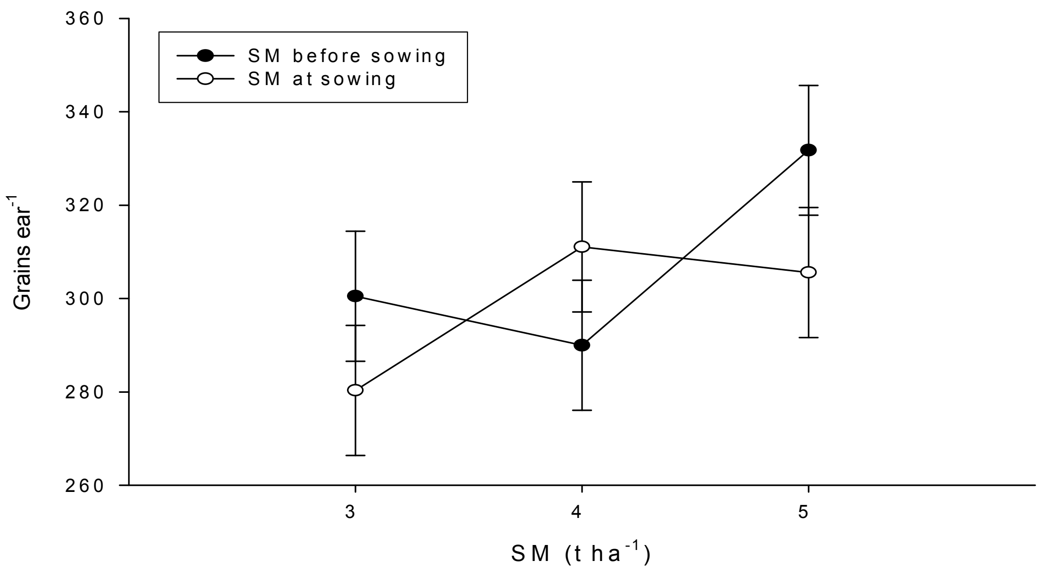

Fig. 4: Interactive response of sheep manure (SM) and application time (AT) for number of grains ear^{-1}.

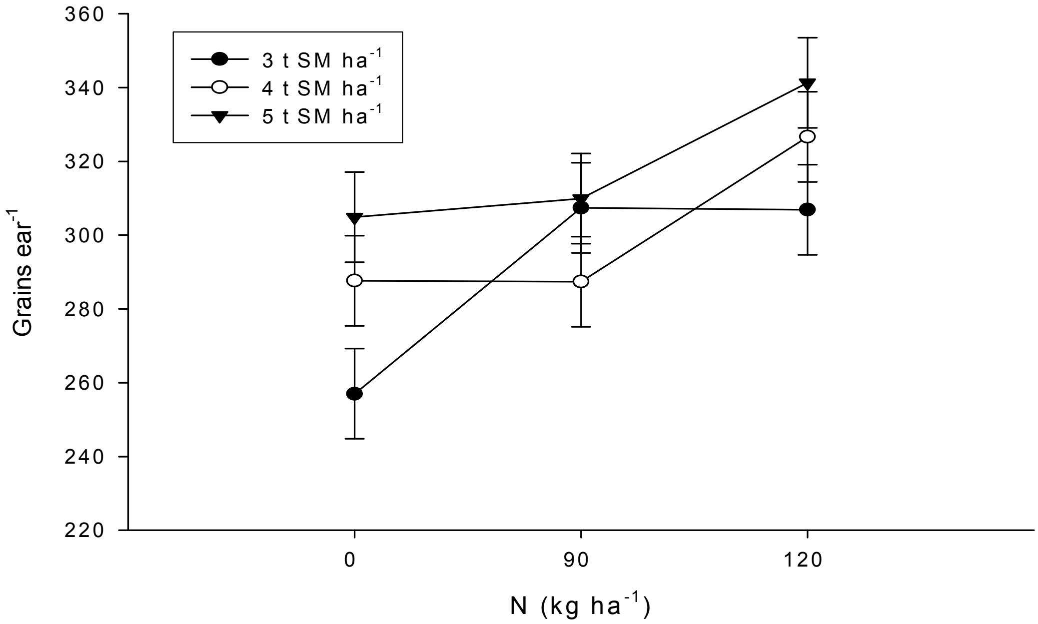

Fig. 5: Interactive response of sheep manure (SM) and nitrogen (N)for number of grains ear^{-1}.

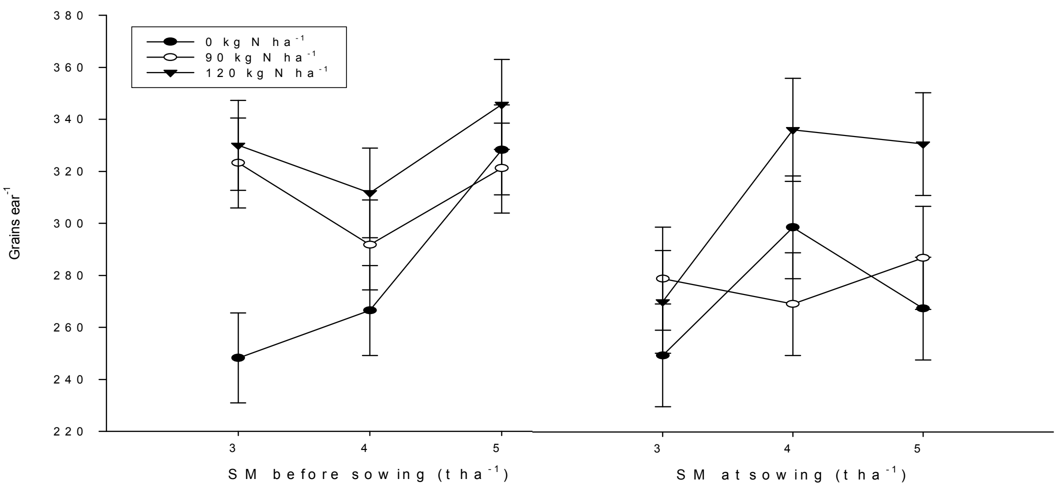

Fig. 6: Sheep manure (SM), application time (AT), and nitrogen (N) interaction for number of grains ear-1.

1000 grains weight (g)

Data analysis indicated that 1000 grains weight (Table 4) was influenced by sheep manure, its application timing and nitrogen levels. Among various interactions, only SM x N, was found significant.

Mean values indicated that 5 t ha^{-1} sheep manure produced maximum 1000 grains weight(241.1 g), while lighter grains (232.5 g) were obtained from 3 t ha^{-1} sheep manure application. The higher 1000 grains weight from increased level of sheep manure could be due to greater leaf area and leaf area index produced by these plants probably due to improved aeration, aggregate stability, hydraulic conductivity, infiltration rates, and biological activities of soil as a result of manure (Dauda *et al*., 2008), that might had increased the dry matter production and its translocation toward the grains (Buriro *et al*., 2014).These results are similar to the experimental report of Farhad *et al*. (2009), and Akongwubel *et al*. (2012) who obtained heaver grains from increasing poultry manure amounts. Heavier grains (238.4 g) were recorded from sheep manure incorporation prior to planting than grains weight (235.1 g) obtained from manure application at sowing time. These results are opposed by Olofintoye (2010) who observed non significant increase in grains weight from application timing of manure, but supported by Omisore *et al.* (2009).

Likewise increasing nitrogen levels enhanced grains weight. 120 kg ha^{-1} nitrogen fertilization produced heavier grains (244.2 g) while lighter grains (230.4 g) were recorded from control plots. Increase in 1000 grains weight with higher N levels was probably due to increased chlorophyll content associated with higher leaf area, which lead to enhanced photosynthetic rate, and ultimately higher assimilates available at grain filling stage (Manzoor *et al*., 2006). Khan *et al*. (2005), and Hokmalipour and Darbandi (2011) also reported similar results. The SM x N interaction (Fig 7) showed that 1000 grains weight increased significantly in all three levels of sheep manure (3, 4 and 5 t ha^{-1}) with incremental N levels from 0 to 120 kg ha^{-1}. The increase in 1000 grains weight with 3 and 4 t ha^{-1} was linear, while in 5 t ha^{-1} sheep manure applied plots it first increased slightly from 0 to 90 kg ha^{-1}, however from 90 to 120 kg N ha^{-1} the increase was abrupt.Integrated application of sheep manure and urea produced heaviest grains than sole application of these nitrogen sources. This increase could be related to enhance nutrient use efficiency and reduced nutrient loses from integrated use. These results are in support to those obtained by Shah *et al*. (2009) and Mohsin *et al*. (2012).

Table 4: 1000 grains weight of maize as affected by sheep manure and urea fertilizer.

Sheep manure (SM, t ha^{-1})	Application time of SM (AT, days)†	Nitrogen rates (N, kg ha^{-1})			SM x AT
		0	90	120	
3	15	232.3	235.0	242.3	236.5
4		232.0	238.8	242.5	237.8
5		235.5	237.5	249.8	240.9
3	0	221.5	230.5	233.3	228.4
4		227.0	235.5	244.0	235.5
5		234.3	236.3	253.3	241.3
	15	233.3	237.1	244.8	238.4 a
	0	227.6	234.1	243.5	235.1b
3		226.9	232.8	237.8	232.5 c
4		229.5	237.1	243.3	236.6 b
5		234.9	236.9	251.5	241.1 a
Mean		230.4 c	235.6b	244.2 a	

†*SM application was made 15 or 0 days before sowing*

Interactions		P-values	Interactions		P-values
SM x AT	=	0.085	AT x N	=	0.192
SM x N	=	0.015	SM x AT x N	=	0.475
$LSD_{0.05}$ for SM and AT	=	3.8, 3.1	$LSD_{0.05}$ for N	=	2.4

Means having similar alphabet(s) within the same group are statistically comparable using LSD test at P≤0.05.

Grain yield (kg ha^{-1})

Perusal of the data showed that maize grain yield was profoundly influenced by sheep manure, application timing of SM and nitrogen levels (Table 5). Among various interactions only AT x N and SM x AT x N were found non significant for grain yield.

Mean table showed that application of 5 t SM ha^{-1}produced maximum grain yield (3401 kg ha^{-1}) while minimum grains yield (2512 kg ha^{-1}) was recorded from 3 t SM ha^{-1}. This increased production of grain yield from higher level of sheep manure could be due to enhanced soil fertility that in turn had enhanced nutrient provision, for optimum plant growth (Ali, 2011), absorb essential nutrients such as Fe^{2+}, Mg^{2+} and NH^{4+} cations, which are indispensible for enzymes activation and chlorophyll formation (Elhindi, 2012), increased organic matter, (Shadanpour, 2011). These improved soil properties might have increased yield components and hence the grain yield. The increased grain yield with increasing levels of manure was also reported by Farhad *et al*. (2009). Incorporation of SM 15 days before planting produced higher grain yield (3099 kg ha^{-1}) than manure application at planting time (2748 kg ha^{-1}).This high yield with manure application at before sowing could be associated with better mineralization of sheep manure, synchronization of nutrient release at proper growth stage, and long term soil fertility from higher rates of manure application before sowing (Olofintoye, 2010), that might have improved plant growth and yield components of maize. These results are in agreement with Omisore *et al*. (2009) and Thulasizwe and Simeon (2013) who observed higher grain yield from manure application prior to planting. Higher doses of nitrogen(120 kg ha^{-1}) produced higher grain yield(3447 kg ha^{-1}) than 90 kg ha^{-1} N (2981 kg ha^{-1}) while lowest yield grains yield (2341kg ha^{-1}) was obtained from control. Increased level of N was found to have significantly enhanced grain yield. The conclusion of Radma and Dagash (2013) are in conformity to our finding who observed higher grain yield from increasing N levels. AT x M interaction (Fig 8) showed that

Table 5: Grain yield (kg ha^{-1}) of maize as influenced by sheep manure and urea fertilizer.

Sheep manure (SM, t ha^{-1})	Application time of SM (AT, days)†	Nitrogen rates (N, kg ha^{-1}) 0	90	120	SM x AT
3	15	2066	3125	3117	2769
4		2037	3090	3111	2746
5		3504	3250	4591	3782
3		1684	2893	2187	2255
4	0	2342	2812	3752	2969
5		2420	2717	3929	3022
	15	2535	3155	3606	3099 a
	0	2149	2808	3290	2749 b
3		1875	3009	2652	2512 c
4		2189	2951	3431	2857 b
5		2962	2984	4260	3402 a
Mean		2342c	2981 b	3448 a	

†SM application was made 15 or 0 days before sowing

Interactions		P-values	Interactions		P-values
SM x AT	=	0.014	AT x N	=	0.962
SM x N	=	0.000	SM x AT x N	=	0.086
$LSD_{0.05}$ for SM and AT	=	320, 261	$LSD_{0.05}$ for N	=	258

Means bearing identical letter (s) in the same column are comparable using LSD test at P≤0.05.

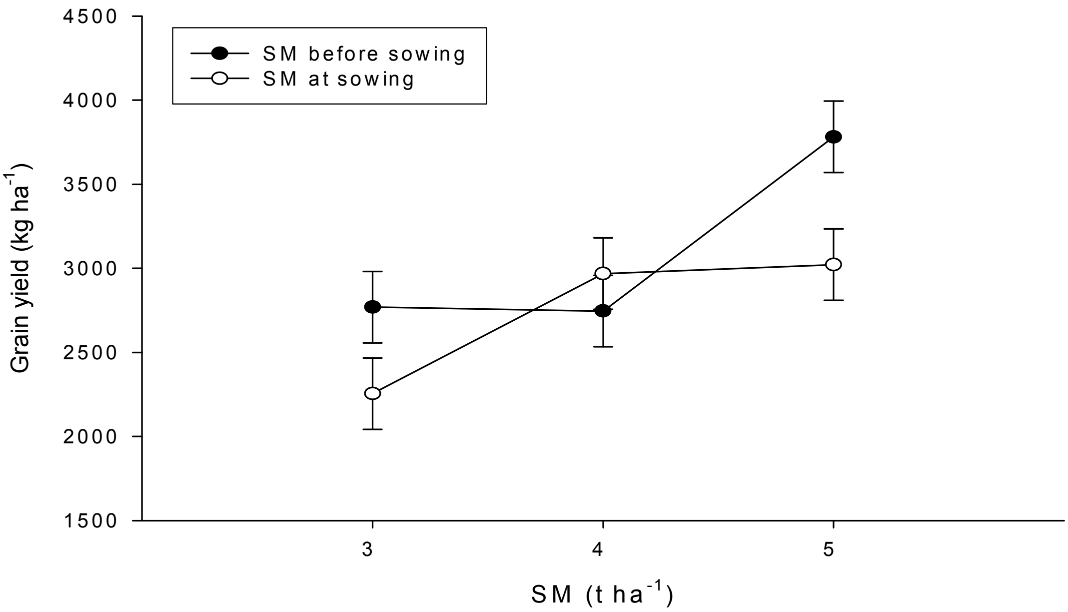

Fig. 8: Sheep manure (SM) and application time (AT) interaction for grain yield (kg ha^{-1}).

increasing the sheep manure from 4 to 5t ha^{-1}had increased the grain yield when SM incorporation was made before sowing, however the grain yield at 3 or 4 t SM ha^{-1} was non-significant. Moreover, the application SM at sowing showed that increasing the sheep manure from 3 to 4 t ha^{-1}had increased the grain yield, but no further increased was observed with increasing SM up to 5 t ha^{-1}, Regarding SM x N interaction (Fig 9) it was observed that increasing N had increase the grain yield linearly in plots having 5 t SM ha^{-1}. However, in plots having 4 t SM ha^{-1}, increasing N up to 90 have no effects on grain yield and with further increased up to 120 kg N ha^{-1}, the grain yield increased. Likewise, no differences in grain yield was recorded in 3 t SM ha^{-1}treated plots, when 90 or 120 kg ha^{-1}nitrogen was applied, but were significantly higher than those recoded in control plots. Combined application of sheep manure and fertilizer N produced higher grain yield than their sole application. The possible reason for this improved yield could be efficient mineralization of manure, with starter N to microbes available from urea, which might enhanced mineralization, thus ensured nutrient availability throughout the growing season, and enhanced soil fertility (Ali, *et al*., 2012), improved soil moisture, CEC of soil, provide a medium for adsorption of different nutrients, and improved activities of soil micro-organism (Sohi *et al*., 2009), that might resulted in higher yield component and ultimately grain yield. These results are in line with Shah *et al*. (2009), Mohsin *et al*. (2012), and Ogundare (2015).

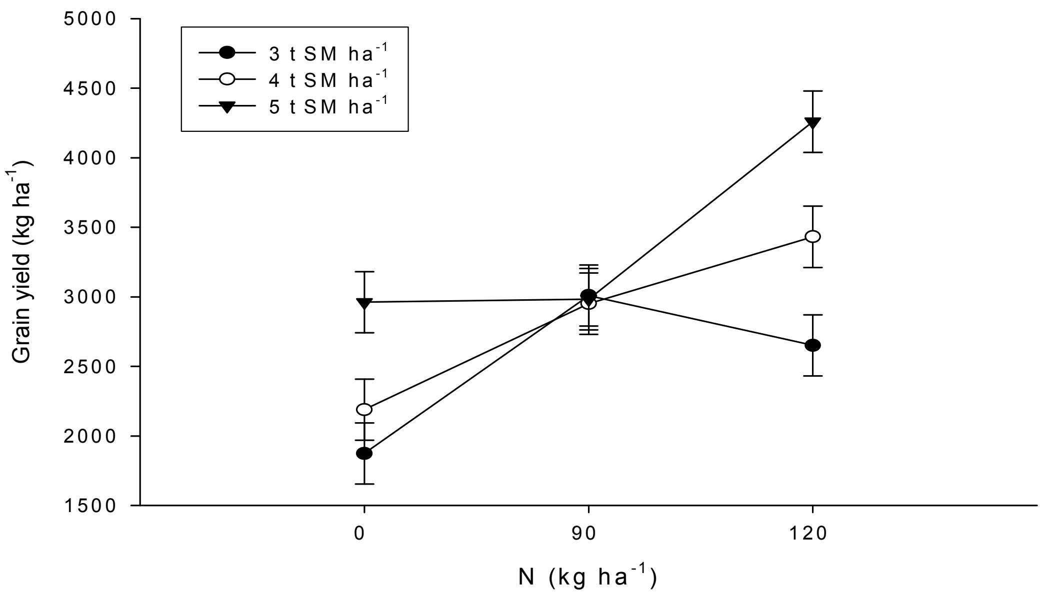

Fig. 9: Interactive response of sheep manure (SM) and nitrogen (N)for grain yield (kg ha^{-1}).

Conclusion

On the basis of finding obtained in the experiment it was concluded that, 5 t ha^{-1} sheep manure(SM) incorporation produced optimum yield and yield attributes in maize. Application of SM15 days before sowing had resulted in higher yield and yield component. Application of 120 kg N ha^{-1} boosted maize yield and yield components. The combined application of 120 kg N ha^{-1} and 5 t SM ha^{-1} produced optimum yield and yield attributes over the sole application of either SM or N or control. Based on the results of the study and conclusions drawn, it is recommended that 5 t SM ha^{-1} should be incorporated 15 days before sowing, along with 120 kg N ha^{-1} for obtaining optimum dry matter, yield and yield attributes for maize (cv. Azam) in agro-climatic condition of the Peshawar.

References

Achieng, J. O., G. Ouma, G. Odhiambo and F. Muyekho, 2010. Effect of farmyard manure and inorganic fertilizers on maize production on Alfisols and Ultisols in Kakamega, western Kenya. Agric. Biol. J. N. Am., 1(4): 430-439.

Adami, P. F., A. Pelissari, A. D. Moraes, A. J. Modolo, T. S. Assmann, M. F. Franchin and L. C. Cassol, 2012. Grazing intensities and poultry litter fertilization levels on corn and black oat yield. Pesq. Agropec. Bras., Brasília, 47(3): 360-368.

Akongwubel, A. O., U. B. Ewa, A. Prince, O. Jude, A. Martins, O. Simon and O. Nicholas, 2012. Evaluation of agronomic performance of maize (*Zea mays* L.) under different rates of poultry manure application in an Ultisol of Obubra, cross river state, Nigeria. Int. J. Agric.Forest., 2(4): 138-144.

Ali, K., F. Munsif, M. Zubair, Z. Hussain, M. Shahid, I. U. Din and N. Khan, 2011. Management of organic and inorganic nitrogen for different maize varieties. Sarhad J. Agric. 27: 525-529.

Ali, S., S. Uddin, O. Ullah, S. Shah, S. U. Din, T. Ali and I. U. Din, 2012. Yield and yield components of maize response to compost and fertilizer-nitrogen. Food Sci. Qual. Manag., 38: 39-44.

Arif, M., I. Amin, M. T. Jan, I.Munir, K. Nawab, N.U. khan and K.B.Marwat, 2010. Effect of plant population and nitrogen levels and methods of application on ear characters and yield of maize. Pak. J. Bot., 42(3): 1959-1967.

Baiyeri, K. P. and A. Tenkouano, 2008. Manure placement effects on root and shoot growth and nutrient uptake of 'PITA 14' Plantain hybrid (*Musa sp.*Aaab). Africa J. Agric. Res. 3(1): 13-21.

Baloch, P. A., B. A. Abro, A. S. Chandio, N. Depar and M. A. Ansari, 2015. Growth and yield response of maize to integrated use of *Gliricidiasepium*, farm manure and NPK fertilizers.Pak. J. Agri., Agril. Engg., Vet. Sci., 3(1): 14-23.

Boomsma, C. R., J. B. Santini, M. Tollenaar and T.J. Vyn, 2009. Maize morpho-physiological responses to intense crowding and low nitrogen availability: An analysis and review. Agron. J.,101: 1426-1452.

Buriro, M., A. Oad, T. Nangraj and A.W. Gandahi, 2014. Maize fodder yield and nitrogen uptake as influenced by farm yard manure and nitrogen rates. European Acad. Res. 2(9): 11624-11637.

Chen, J. S., R. F. Zhu and Y. X. Zhang, 2013. The effect of nitrogen addition on seed yield and yield components of *Leymuschinensis* in Songnen Plain, China. J. Soil Sci. Plant Nutr., 13 (2): 329-339.

Cechin, I. and T. D. F. Fumis, 2004. Effect of nitrogen supply on growth and photosynthesis of sunflower plants grown in the greenhouse. Plant Sci., 166: 1379-1385.

Dekisissa T., I. Short and J. Allen, 2008. Effect of soil amendment with compost on growth and water use efficiency of amarannath. In: Proc. of UCOWR/NIWR Annual Conf. Int'l. Water Resources: Challenges for the 21st Century and Water Resources Education: 22-24, Durham, NC.

Dauda, S. N., F. A. Ajayi and E.Ndor, 2008.Growth and yield of water melon (*Citrulluslanatus*) as affected by poultry manure application. J. Agric. Soc. Sci. 4: 121-124.

Dolan, M. S., M. F. Saleem, M. A. Cheema and H. M. Hammad, 2006. Effect of poultry manure level on the productivity of spring maize. J. Ani .and plant Sci.19 (3): 122-125.

Edmeades, D. C, 2003. The long term effects of manures and fertilizers on soil productivity and quality. Nutrient Cycling in Agroecosystems 66:165-180.

Elhindi, K, 2012. Evaluation of composted green waste fertigation through surface and sub surface drip irrigation systems on pot marigold plants (*Calendula officinalis*L.) grown on sandy soil. Australian J. Crop Sci., 6(8): 1249-1259.

Ezeibekwe, I. O., C. I. Ogbonnaya and C. I. Onuoha, 2009.Comparative effect of poultry manure and urea on the growth and yield of maize (*Zeamays*L.). Report and Opinion; 1(4).

Fageria, N. K. 2012. Role of soil organic matter in maintainingsustainability of cropping systems. Commu. Soil Sci. Plant Anal., 43(16): 2063-2113.

Farhad, W., M. F. Saleem, M. A. Cheema and H. M. Hammad, 2009. Effect of poultry manure levels on the productivity of spring maize. J. Animal Plant Sci. 19(3): 122-125.

Hokmalipour, S. and M. H. Darbandi, 2011. Investigation of nitrogen fertilizer levels on dry matter remobilization of some varieties of corn (*Zeamays*L). World Appl. Sci. J. 12(6): 862-870.

Hopkins, B. G., C. J. Rosen, A. K. Shiffler and T. W. Taysom, 2008. Enhanced efficiency fertilizers for improved nutrient management of potato. University of Idaho, Aberdeen.

Iqbal, A., M. A. Iqbal, A. Raza, N. Akbar, R. N. Abbas and H. Z. Khan, 2014. Integrated nitrogen management studies in forage maize. Ameri. Eura. J. Agric. &Envi. Sci., 14 (8): 744-747.

Jalali, M. and F. Ranjbar, 2009. Effects of sodic water on soil sodicity and nutrient leaching in poultry and sheep manure amended soils. Geoderma, 153: 194–204.

Karasu, A., 2012. Effect of nitrogen levels on grain yield and some attributes of some hybrid maize cultivars (*Zea mays indentata*sturt.) grown for silage as second crop. Bulgarian J. Agric. Sci., 18(1): 42-48.

Khaliq, T., T. Mahmood, J. Kamal and A. Masood, 2004. Effectiveness of farmyard manure, poultry manure and nitrogen for corn (*Zea mays* L.) productivity. Int. J. Agri. Biol., 6(2): 60-63.

Khan, A., A. Jan and S. Alam, 2005. Effect of nitrogen and seed size on maize crop II: yield and yield components. J. Agric. Soc. Sci., 1(3): 18-23.

Khatoon, T., K. Hussain, A. Majeed, K. Nawaz and M.F. Nisar, 2010. Morphological variations in maize (*Zea mays* L.) Under different levels of NaCl at germinating stage. World Appl. Sci. J., 8(10): 1294-1297.

Le Gouis, J., B. Hirel, B. Ney and A. Gallais, 2007. The challenge of improving nitrogen useefficiency in crop plants: towards a more central role for genetic variability and quantitativegenetics within integrated approaches. J. Exp. Bot., 58: 2369–2387.

Manzoor, Z., T. H. Awan, M. A. Zahid and F. A. Faiz. Response of rice crop (Super Basmati) to different nitrogen levels. J. Anim. Pl. Sci. 16(1-2): 52-55.

Mohsin, A. U., J. Ahmad, A. U. H. Ahmad, R. M. Ikram and K. Mubeen, 2012. Effect of nitrogen application through different combinations of urea and farm yard manure on the performance of spring maize (*Zea mays* L.). J. Animal Plant Sci., 22(1): 195-198.

Ogundare, S. K., I. J. Babatunde, M. O. Aduloju and A. S.Hinmikaiye, 2015. Effect of *Chromolaena odorata* residue and urea fertilizer on plant available nitrogen, growth and yield of maize (*Zea mays* L.) in Ejiba, Kogi State, Nigeria. Int. J. Res. Agri. Forest., 2(8): 1-5.

Olofintoye, J. A, M. O. S. Ododo and V. Mikindi, 2010. Maize response to a synthetic organic nitrogen f'ertilizer, poultry manure and time of application in the Guinea Savannah of Nigeria. J. Agric. Res. Dev. 7(2).

Omisore, J. K., O. A. Oyelade and O. T. D. Joel, 2009. Effects of application timing on maize production using poultry manure. National Centre for Agricultural Mechanization (NCAM), Ilorin. Pp. 429-435.

Omisore, J. K., M.Y. Kasali and U. C. Chukwu, 2009. Determination of optimum poultry manure rate for maize production. Proceeding of the 43rd Annual Conference of Agricultural Society of Nigeria.

Onasanya, R. O., O. P. Aiyelari, A. Onasanya, S. Oikeh, F. E. Nwilene and O. O. Oyelakin, 2009. Growth and yield response of maize (*Zeamays*L.) to different rates of nitrogen and phosphorus fertilizers in southern Nigeria. World J. Agri. Sci., 5(4): 400-407.

Ozores, H. M, 2012. Developing a vegetable fertility program using organic amendments and inorganic fertilizers. Hort. Tech. 22(6): 742–750.

Radma, I. A. M. and Y. M. I. Dagash, 2013. Effect of different nitrogen and weeding levels on yield of five maize cultivars under irrigation.Univ. J. Agric. Res., 1(4): 119-125.

Randall, G. W., J. A. Vetsch and J. R. Huffman, 2003. Corn production on a subsurface-drained mollisol as affected by time of nitrogen application and nitrapyrin. Agron. J. 95: 1213–1219.

Sarwar G., N. Hussien, H. Schmiesky, S. Muhammed, M. Ibrahim and E. Safdar, 2008. Improvemnet of soil physical and chemical properties with compost application in rice-wheat cropping system. Pak. J. Bot., 40: 275-282.

Shadanpour, F., T. A. Mohammadi and M. K. Hashemi, 2011. The effect of cow manure vermicompostas the planting medium on the growth of marigold. Annals Biol. Res., 2(6): 109-115.

Shah, K. P. and M. Arif, 2000. Management of organic farming: Effectiveness of farmyard manure (FYM) and nitrogen for maize productivity. Sarhad J. Agric., 16: 461–465.

Shah, S. T. H., M. S. I. Zamir, M. Waseem, A. Ali, M. Tahir and W.B.Khalid, 2009.Growth and yield response of maize (*Zea mays* L.) to organic and inorganic sources of nitrogen. Pak. J. life soil. sci., 7(2): 108-111.

Sohi, S., E. L. Capel, E. Krull and R. Bol, 2009. Biochar's roles in soil and climate change: A review of researchneeds. CSIRO Land & Water Sci. Report 05/09. 64p.

Thomsen, I. K., 2005. Crop N utilization and leaching losses as affected by time and method of application of farmyard manure. Europe. J. Agron., 22: 1- 9.

Thulasizwe, S. M. and A. M. Simeon, 2013. Influence of kraal manure application time on emergence, growth and grain yield of maize grown in two soils with contrasting textures. J. Food, Agri. Env., 11(1): 422-427.

Verma, S. S. Marker, Dipika, and G. J. Synrem, 2014. Effect of combined use of organic and inorganic fertilizers on maize. Annals of Plant Soc. Res., 16(1): 77-78.